

Morphofunctional Adaptations of Parasitoids Attacking Concealed Eggs of Two Arboreal Mirids in Italy

ERIC CONTI, PIO F. ROVERSI, AND FERDINANDO BIN

(EC, FB) Department of Arboriculture and Plant Protection, University of Perugia, Borgo XX Giugno, Perugia, 06121 Italy; (PFR) Experimental Institute for Agricultural Zoology, Forest Entomology Section, Ministry for Agricultural Politics, Via Lanciola 12/A, Firenze, 50125 Italy

Abstract.—The morphofunctional adaptations of the egg parasitoids of two arboreal mirids (Heteroptera: Miridae) for reaching the concealed eggs of their hosts, *Calocoris quadripunctatus* (Villers) and *Calocoris trivialis* (Costa), were studied in a natural ecosystem (oak forest) and in an agroecosystem (orange groves), respectively. *Calocoris quadripunctatus* is a predator of immature stages of *Tortrix viridana* (L.) (Lepidoptera: Tortricidae) in deciduous oak forests, *Quercus* spp., in Tuscany. Eggs are laid in clusters and concealed among the scales of dead buds, where they are exploited by two parasitoid species. *Chaetostricha walkeri* (Förster) (Hymenoptera: Trichogrammatidae) has a long ovipositor which is inserted between the scales to reach the host eggs, and is therefore an "ovipositor prober". Instead, *Telenomus* sp. *laricis* Walker group (Hymenoptera: Scelionidae) has a depressed metasoma which is introduced between the scales, and is therefore a "metasomal prober". *Calocoris trivialis* is a phytophagous species that damages orange groves, *Citrus sinensis* (L.), and other *Citrus* spp. in Sicily. The eggs are concealed in the soft, decaying wood of old pruning wounds and are attacked by at least two parasitoids. *Aprostocetus* n. sp. near *miridivorus* (Domenichini) (Hymenoptera: Eulophidae) is probably both an "ovipositor prober" and an "ovipositor driller", as it can also drill through the wood. *Telenomus lopicida* Silvestri (Hymenoptera: Scelionidae) has a long ovipositor and a compressed metasoma, which is introduced into the host incision, and is therefore a "metasomal prober". Such morphological adaptations appear to be linked to the host oviposition sites and explain some aspects of parasitoid exploitation efficiency; they may also help interpret other host-parasitoid associations that are unknown or questionable.

Mirid bugs (Heteroptera: Miridae), the largest family of Heteroptera, are very common both in arboreal and herbaceous ecosystems, where they feed on plants (phytophagous species), other arthropods (zoophagous) or both (zoophytophagous) (Wagner and Weber 1964, Alomar and Wiedenmann 1996). Their eggs are elongated with a true operculum on their anterior pole and are more or less deeply embedded in dead or living plant tissues, or concealed between plant organs (Kullenberg 1946, Southwood 1956, Cobben 1968, Hinton 1981). In spite of these kinds of protection, mirid eggs can be attacked by parasitoids belonging to Eulophidae, Trichogrammatidae, Scelionidae and My-

maridae (Hymenoptera) (Bin and Vinson unpublished). Some of these host-parasitoid associations from a natural ecosystem, oak forest, in Tuscany (central Italy) and from an agroecosystem, orange groves, in Sicily (southern Italy), are described here, focusing on morphological features related to parasitoid strategies.

Oaks in Tuscany are attacked by *Tortrix viridana* (L.) (Lepidoptera: Tortricidae), which is distributed over large portions of the Palearctic region, from northern Europe to the Mediterranean region, and during population outbreaks can seriously defoliate vast groves (Bogenschütz 1978). Eggs and possibly young larvae of this tortricid are preyed upon (Roversi unpub-

lished) by the zoophytophagous mirid *Calocoris quadripunctatus* (Villers) (Wagner and Weber 1964), the population size of which was found to be directly dependent on *T. viridana* density (Roversi *et al.* in preparation). *Calocoris quadripunctatus* has one generation per year and overwinters in the egg stage. Eggs are concealed in dead buds, between external scales that are partially spaced out, where they are attacked by *Chaetostricha walkeri* Förster (Hymenoptera: Trichogrammatidae) and a *Telenomus* sp. (Hymenoptera: Scelionidae) (Conti *et al.* 1997, Roversi *et al.* 1998) which belongs to the *T. laricis* Walker species group (Huggert 1983, Johnson 1984); both are new host records. Parasitoid impact on the predator, pooled for the two species, averaged 17% in 1994 (Conti *et al.* 1997, Roversi *et al.* in preparation).

Orange groves in Sicily are attacked by the phytophagous mirid *Calocoris trivialis* (Costa), which causes apical deformation of shoots, leaf necrosis and drop of flower buds (Barbagallo 1970). This mirid also has one generation per year and overwinters in the egg stage, but the eggs are embedded in the soft dead and decaying wood of old pruning wounds. These eggs are attacked by *Aprostocetus miridivorus* (Domenichini) (Barbagallo 1969, 1970, Graham 1987), *Aprostocetus* new species near *miridivorus* (Hymenoptera: Eulophidae) (Conti *et al.* 1991, 1997) and *Telenomus lopicida* Silvestri (Hymenoptera: Scelionidae) (Barbagallo 1970, Conti *et al.* 1991, 1997). Total parasitoid impact averaged 57–70% in the different years and locations (Barbagallo 1969, 1970, Conti *et al.* 1991, 1997, Roversi *et al.* in preparation). *Aprostocetus miridivorus* and *T. lopicida* were also recorded from overwintering eggs of the mirid *Capsodes lineolatus*, deeply embedded inside incisions in herbaceous plants (Silvestri 1932, 1939, Graham 1987). However, it is unknown whether the same parasitoids shift between two alternative hosts or if they are two different

biotypes, with different habitat preferences.

Some aspects of these mirid—egg parasitoid associations on oak and orange groves are described in this paper by combining observations on host oviposition sites and parasitoid morphological adaptations, with the aim of defining oviposition strategies.

MATERIALS AND METHODS

Sampling Procedures

Oak groves.—Field research on egg parasitoids associated with *C. quadripunctatus* was carried out in five permanent sampling areas with mixed stands of *Quercus pubescens* Will. and *Q. cerris* L., ranging from 350 m to 700 m above sea level, in central Tuscany (central Italy). *Quercus pubescens* is included in the overstorey, as the masts are more palatable to livestock, while *Q. cerris* is part of the understorey and is used mainly for timber. In this landscape of gently rolling hills, oak stands normally alternate with vineyards and olive groves.

During the winters of 1994 and 1996, 36 branches, 1 m long, were collected in each sampling area (total 180 branches) and transferred to the laboratory. All dead buds were counted, collected and kept under a shelter at outdoor conditions. In spring, when nymphs and parasitoids had emerged, buds were dissected and examined under the stereomicroscope.

Orange groves.—Overwintering eggs of *C. trivialis*, embedded in the soft decayed wood of the pruning wounds, were collected on 9–10 January 1991 and 2–5 February 1992 in 6 orange, *Citrus sinensis* (L.), groves, the same both years, in 5 localities of the Provinces of Catania and Siracusa (Sicily, southern Italy).

Pruning wounds of different sizes and suitable for oviposition by *C. trivialis* were sampled randomly over the whole area of the groves. Twenty (20) to 62 samples per grove were collected in 1991 (total 224

samples), 30 per grove in 1992 (total 180 samples). The samples were then transferred to the laboratory and kept under controlled conditions (25 ± 1 °C, 60%-95% RH; photoperiod L:D 14:10) in different kinds of screened containers (30×160 mm glass tubes, 140×25 mm Petri dishes, $185 \times 140 \times 290$ mm plastic food containers), depending on the size of the samples. All the material was examined under the stereomicroscope in summer, when emergence of nymphs and parasitoids was complete.

Host Oviposition Sites and Parasitoid Structures

For both species of *Calocoris*, eggs were classified in the following categories:—healthy (i.e., eclosed),—parasitized (i.e., containing the parasitoid or with the presence of an emergence hole),—dead due to other agents (predators or unknown). Egg length was measured under a stereomicroscope and the characteristics of healthy and parasitized eggs were described. In the case of *C. quadripunctatus*, the distribution of healthy and parasitized eggs in each cluster was mapped.

The position of the parasitoid piercing point on the host egg was recorded when visible under the stereoscopic or compound microscope. However, on eggs of *C. trivialis* such parasitoid punctures are often hidden by remains of wood that are glued to the chorion, due to a sticky secretion from the ovipositing female. In an attempt to dissolve this secretion, eggs were sonicated at room temperature for at least 15 minutes in different solvents (water, ethanol, acetone, chloroform), or soaked in boiling chloroform (61.2 °C) in a beaker inside a water bath for 15 minutes.

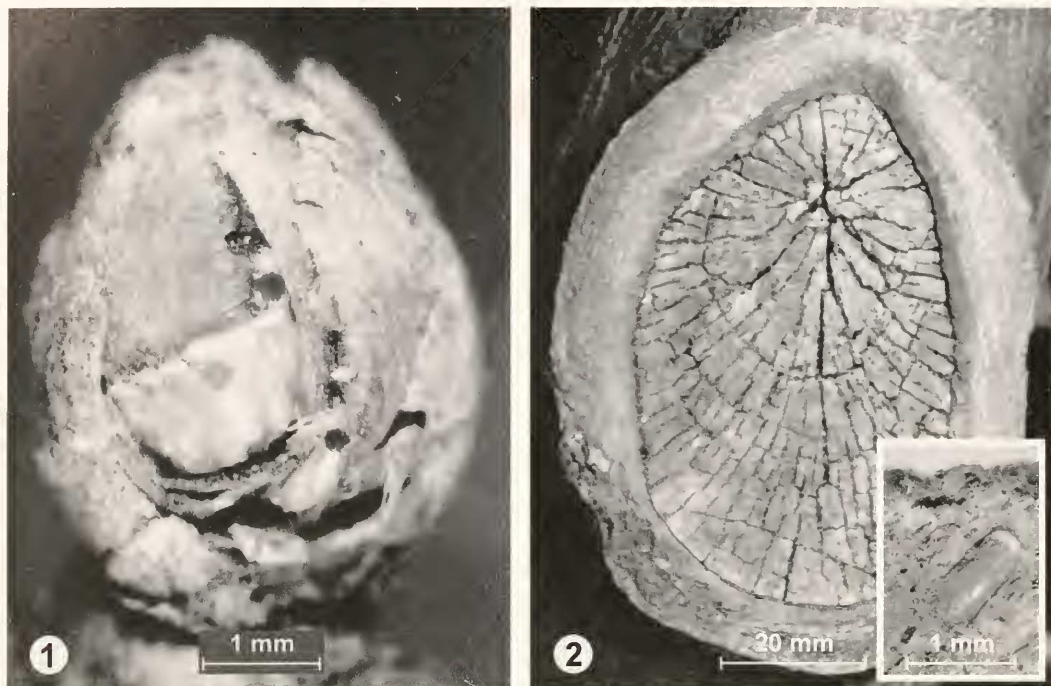
Parasitoids' structures used for reaching the concealed host eggs were evaluated by measuring the total body length, metasoma size and ovipositor length of 5 or 10 females of each species. To measure ovipositor length, the two scelionids were

cleared with potassium hydroxide and mounted on slides. Measurements were made using a micrometer eyepiece mounted on a compound microscope, or under a Nikon E 600 microscope connected to a JVC TK-C1380 video camera, and using a computer program for visual image analysis (Lucia 3.5).

RESULTS AND DISCUSSION

Host oviposition sites.—The eggs of *C. quadripunctatus*, concealed among the scales of dead buds on oak, are laid in clusters, most frequently with 3 to 5 eggs, and nothing appears externally to indicate their presence. In 1994 and 1996 buds with eggs contained on average 6 to 8 clusters each (Roversi *et al.* in preparation) (Figs. 1, 3 and 4). In contrast, the eggs of *C. trivialis*, concealed in the pruning wounds on orange trees, are laid singly and distributed variably on the wound surface where the decaying wood is soft enough for oviposition. The wounds sampled in 1991 and 1992 had a very variable diameter, from 13 to 98 mm, with an average of 45 mm. Wounds with eggs contained on average 8.3 eggs each in 1991 and 5.1 in 1992. Normally these eggs were deeply embedded, with the operculum at 386 ± 37.2 μm (Mean \pm SEM, $n = 10$) under the substrate and not visible externally, although partially exposed eggs were also found in rare cases. The oviposition incisions, that indicate egg presence, may close partially or completely when rainwater swells the wood, thus becoming inconspicuous or totally invisible (Figs. 2, 11 and 12).

Both the dead buds on oak and the pruning wounds on orange trees contained recently laid eggs and eggs that had been laid during previous seasons, thus indicating that they provide a suitable oviposition substrate for several years. Also, because of wood erosion by atmospheric agents, old egg shells of *C. trivialis* on pruning wounds were often more or less exposed and directly visible



Figs. 1-2. 1, Dead oak bud partially dissected to show egg clusters of *Calocoris quadripunctatus* concealed between scales. 2, Pruning wound with soft decaying wood on orange tree and, in the inserted photo, a cross section partially exposing an embedded egg of *Calocoris trivialis*.

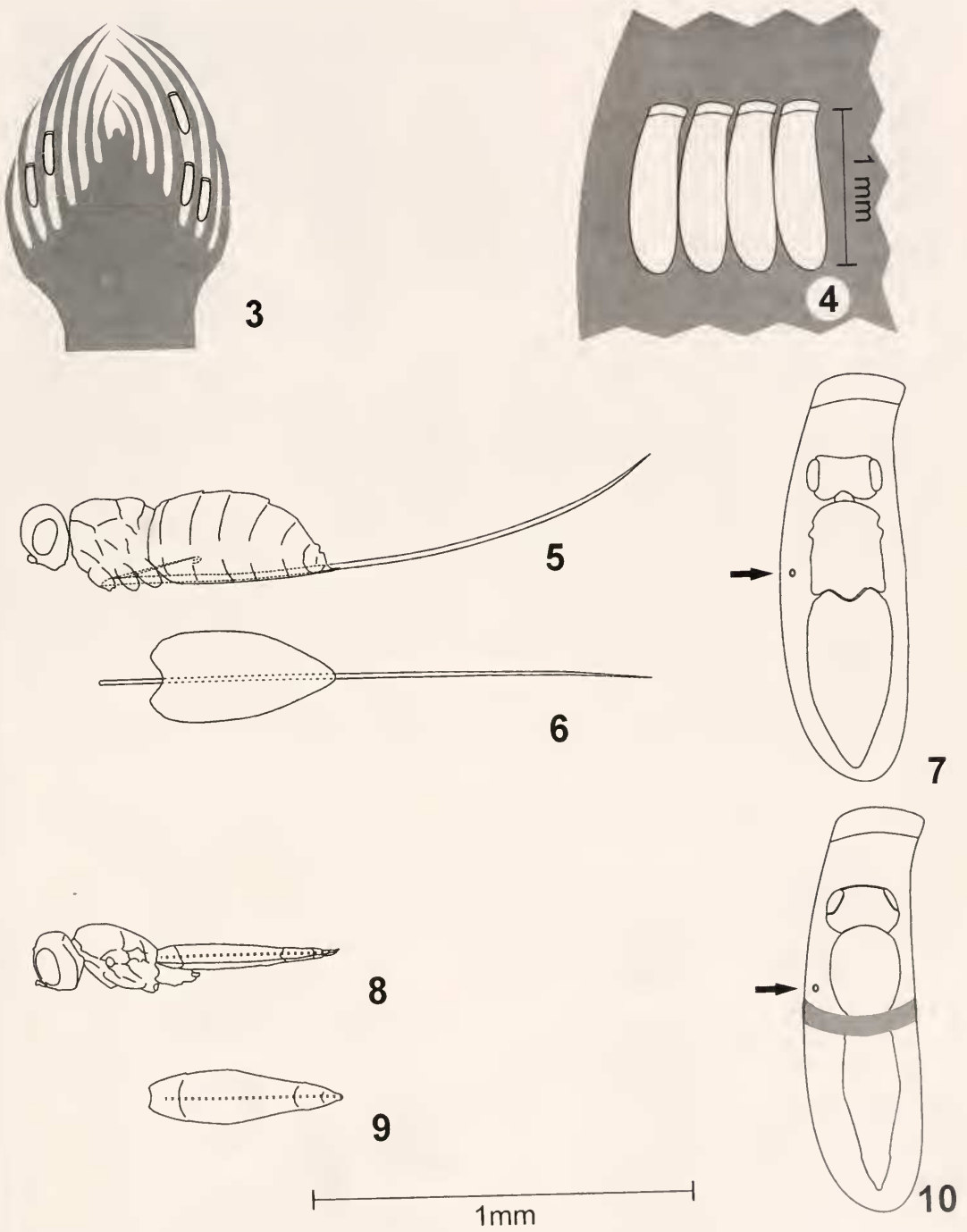
under the stereomicroscope or even to the naked eye.

Parasitoids' morphological adaptations and strategies.—How do the parasitoids reach and attack such concealed and, therefore, protected eggs?

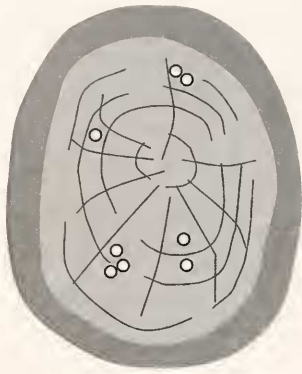
The egg parasitoids of *C. quadripunctatus* in oak buds have developed two different morphological adaptations and strategies (Figs. 5, 6, 8 and 9). The trichogrammatid *Chaetostricha walkeri* has a very long ovipositor, 3.15 times the length of its metasoma. The proximal end reaches the prothoracic coxae, where it is articulated on a special structure, probably used as an extension device (Figs. 5 and 6, Table 1). In contrast, the scelionid *Telenomus sp. laricis* group has a depressed (dorso-ventrally flattened) metasoma, 69% of the length of the whole body, which facilitates its insertion between bud scales. The ovipositor is 86% of the length of the metasoma and is invaginated in it, from which it is ex-

tended for parasitization (Figs. 8 and 9; Table 1). Similarly, lygaeid egg parasitoids in *Telenomus* and *Eumicrosoma* also have depressed metasoma (A. Polaszek, pers. comm.).

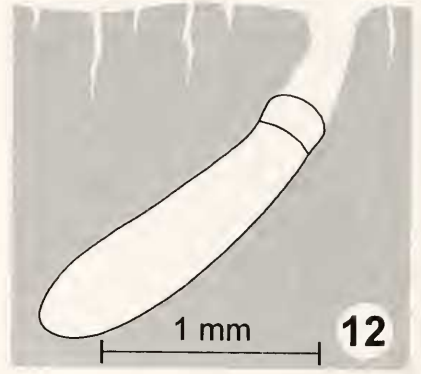
In spite of these adaptations, both *C. walkeri* and *Telenomus sp. laricis* group can hardly reach the most internal eggs, as only the first (peripheral) and second (sub-peripheral) ones are normally attacked, although there are a few exceptions (Roversi *et al.* in preparation). In addition, both parasitoids attack the peripheral egg more frequently than the sub-peripheral one, although *C. walkeri* can reach both much more often than *Telenomus sp.* (Fig. 19). Whether in such cases one species can discriminate between healthy eggs and eggs parasitized by the conspecific or other species is unknown. Similar differences of effectiveness, due to metasoma morphology and ovipositor length, were also observed on species attacking egg masses of the rice



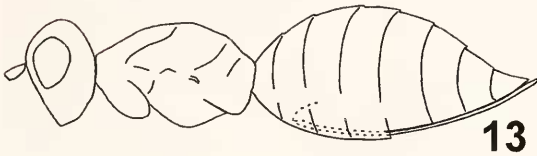
Figs. 3-10. *Calocoris quadripunctatus* and its egg parasitoids. 3, Schematic section of a dead oak bud showing *C. quadripunctatus* egg clusters concealed between scales. 4, Detail of a scale with a cluster of four eggs. 5 and 6, Lateral and dorsal views of *Chaetostricha walkeri* Förster showing the long ovipositor. 7, Host egg parasitized by *C. walkeri* showing the parasitoid piercing point on the chorion. 8 and 9, Lateral and dorsal views of *Telenomus* sp. *laricis* group showing its depressed metasoma with the ovipositor indicated (dotted line). 10, Host egg parasitized by *Telenomus* sp. *laricis* group showing the parasitoid piercing point on the chorion and the characteristic transversal band.



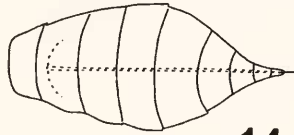
11



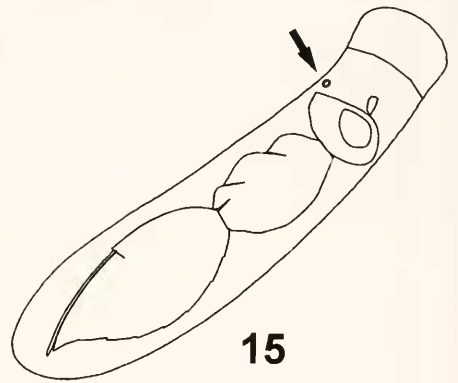
12



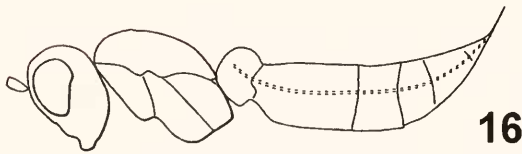
13



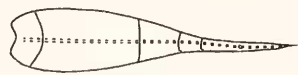
14



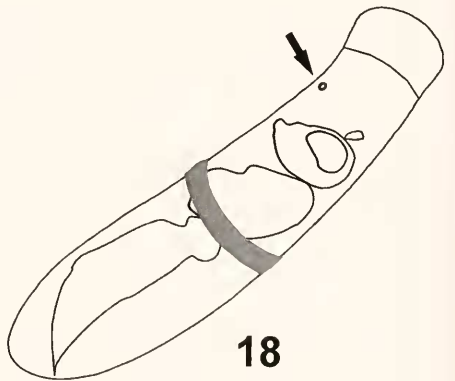
15



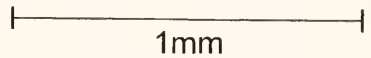
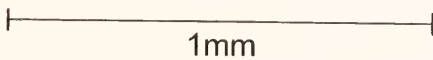
16



17



18



Figs. 11-18. *Calocoris trivialis* and its egg parasitoids. 11, Example of a pruning wound on orange showing a distribution of *C. trivialis* eggs (circles). 12, Schematic section of a host oviposition incision to indicate egg position in relation to the substrate. 13 and 14, Lateral and dorsal views of *Aprostocetus* n. sp. near *miridivorus*. 15, Host egg parasitized by *Aprostocetus* n. sp. near *miridivorus* showing the parasitoid piercing point on the chorion. 16 and 17, Lateral and dorsal views of *Telenomus lopicida* showing its compressed metasoma with the long ovipositor indicated (dotted lines). 18, Host egg parasitized by *T. lopicida* showing the parasitoid piercing point on the chorion and the characteristic transversal band.

Table 1. Measurements (mean ± SEM; in mm) of female parasitoid body parts to show morphological adaptations for reaching the host egg concealed between dead bud scales (*C. quadripunctatus*) or in decaying wood (*C. trivialis*).

Parasitoid	Host	Body length	Metasoma dimensions				
			Length	Lateral		Dorso-ventral (max.)	Ovipositor length
				Max.	Min.		
<i>Chaetostricha walkeri</i> ⁽¹⁾	<i>C. 4-punctatus</i>	0.843 ± 0.022	0.479 ± 0.015	0.268 ± 0.005	—	0.274 ± 0.010	1.511 ± 0.029
<i>Telenomus sp.</i> ⁽²⁾	<i>C. 4-punctatus</i>	0.796 ± 0.020	0.548 ± 0.010	0.141 ± 0.002	—	0.053 ± 0.002	0.472 ± 0.004
<i>Aprostocetus sp.</i> ⁽²⁾	<i>C. trivialis</i>	1.230 ± 0.053	0.652 ± 0.017	0.284 ± 0.008	—	0.330 ± 0.014	0.617 ± 0.025
<i>Telenomus lopicida</i> ⁽²⁾	<i>C. trivialis</i>	1.095 ± 0.018	0.635 ± 0.015	0.162 ± 0.004	0.027 ± 0.005	0.146 ± 0.007	0.832 ± 0.039

⁽¹⁾ n = 10; ⁽²⁾ n = 5.

stemborer *Scirpophaga incertulas* (Walker) (as *Tryporyza incertulas* Walker) (Lepidoptera: Pyralidae) in Vietnam (Vu and Nguyen 1987) and on *Telenomus busseolae* Gahan attacking the maize stemborer *Sesamia nonagrioides* (Lefevre) (Lepidoptera: Noctuidae) in Greece (Alexandri and Tsitsipis 1990).

The egg parasitoids of *Calocoris trivialis* on orange have also developed two different strategies (Figs. 13, 14, 16 and 17). The eulophid *Aprostocetus* n. sp. near *miridivorus* shows no apparent morphological adaptations. The ovipositor is 95% of the

length of the metasoma and is probably introduced into the incision or inserted by drilling through the wooden substrate (Figs. 13 and 14; Table 1). Laboratory observations on the oviposition behavior of *A. miridivorus* towards *Calocoris norvegicus* (Gmelin), indicate that the parasitoid intensely antennates oviposition incisions containing host eggs and, in most cases, inserts its ovipositor through the incision, although it also appears to drill through the dead wood (Conti and Bin unpublished). This is especially important in the open field where, because of wood swell-

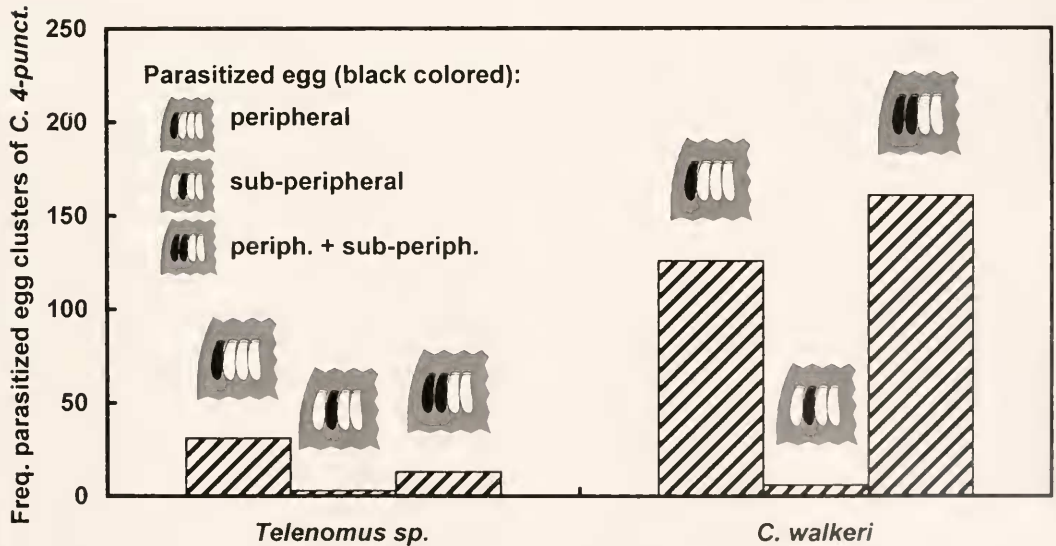


Fig. 19. Frequency of *Calocoris quadripunctatus* egg clusters (4 eggs per cluster on average) parasitized by *Telenomus sp. laricis* group or *Chaetostricha walkeri*, related to the position of the parasitized egg/s in the cluster. For the sake of clarity, the very few cases of more than 2 parasitized eggs per cluster have not been represented in the graph.

ing caused by rain, the incisions can be partially or completely closed.

The scelionid *T. lopicida* presents a much more evident adaptation. The distal half (53% of total length) of its metasoma is laterally compressed and its distal quarter (23%) is only 27 μm wide (Figs. 16 and 17; Table 1). This strongly facilitates its introduction into the host oviposition incisions, as has been observed with eggs of *Capsodes lineolatus* (Brullé) (Heteroptera: Miridae) embedded in stems of *Scabiosa columbaria* L. (Silvestri 1932, 1939). In addition, the ovipositor of *T. lopicida* is 1.31 times the length of the metasoma and is partially contained in a dorso-metasomal hump (Figs. 16 and 17; Table 1).

The parasitoid strategies described above are also confirmed by the position of the parasitoid piercing point on the egg chorion (Figs. 7, 10, 15 and 18). In the case of *C. quadripunctatus*, this point is evidenced by the presence of a brown circular area localized on the exposed side of the egg (Figs. 7 and 10). Such eggs, when parasitized by *C. walkeri*, are visibly swollen and light amber colored. In contrast, those attacked by *Telenomus* sp. *laricis* group are slightly opaque, with a dark transverse band evident from the pupal stage of the parasitoid onwards, and appear darker close to eclosion, due to the presence of the pupa or the adult, visible within.

In the case of *C. trivialis*, the parasitoid piercing point is less recognizable under the microscope because the darkened area is often not appreciable and because part of the chorion is generally hidden by wood remains glued to it. These remains could be removed only mechanically, when possible at all, as the glue is not soluble in any of the solvents tested. The piercing points, when distinguishable, were localized on the apical third of the concave egg side, under the egg cap area (Figs. 15 and 18). No piercing points on the egg cap were observed and, indeed, due to its thickness and hardness, it seems

that this area can be excluded as a piercing site by the parasitoid. Such parasitized eggs of *C. trivialis* were also characterized by a light amber-colored chorion and appeared darker close to eclosion because of the presence of the darkening pupa or the adult, visible within. Similar to *C. quadripunctatus*, eggs of *C. trivialis* parasitized by *T. lopicida* show a dark transverse band at the level of the metathorax (Fig. 18) while those parasitized by *Aprostocetus* sp. do not show any particular pattern (Barbagallo 1969, Mineo and Sinacori 1978) (Fig. 15).

Escaping from the host substrate is another critical situation for which the emerging parasitoids, both males and females, need a morphological adaptation (Quicke 1997). Parasitoids of *C. quadripunctatus* in most cases escape from the buds by crawling out between the scales, although *C. walkeri* may also chew circular holes in the scales. In contrast, both parasitoids of *C. trivialis* have to chew a hole of variable length in the soft decaying wood, depending on their distance from the surface. While in most cases the emergence hole of both species is localized in the apical third of the egg, including the egg cap area, sometimes *T. lopicida* pupates upside-down and therefore has to chew a much longer tunnel in the wood. This is obviously performed with mandibles well adapted to chew plant tissues.

No other adaptive cephalic feature is presented by *T. lopicida* since its frons is smooth, whereas other species, also belonging to the *T. laricis* group, exhibit a marked scale-like sculpture on the frons and vertex (Johnson 1984) probably useful for escaping in combination with mandibles (Bin and Conti unpublished) and have a pointed head, the distinctive feature of the *laricis* group (A. Polaszek, pers. comm.).

CONCLUSIONS

Ideally, host-parasitoid associations should be defined using a complete set of

characters, ranging from physical and chemical cues for habitat and host location, to physiological and biochemical interactions for host suitability. However, some pieces of such a complex mosaic can be provided by comparing the features of the microhabitat, selected by the host to escape adverse climatic events, with the ability of the parasitoid to overcome such physical barriers in order to reach the host and eventually emerge from it.

It is clear that in some cases the morphology of the ovipositor (Austin 1983), the metasoma and, possibly, other body parts are evolutionarily linked to the exploitation of particular hosts. Therefore, in the future these morphological adaptations may be used to predict the most likely host groups or oviposition sites (Austin 1983).

The parasitoid species considered here appear to be well adapted for reaching their concealed host eggs, and the morphological adaptations especially involve the metasoma and/or the ovipositor system. Their oviposition strategies can be defined by comparison with similar strategies described in the literature (Gauld and Hanson 1995, Smith *et al.* 1993; Smith and Wiedenmann 1997), although more direct observations are needed to better understand their behavior. *Chaetostricha walkeri* inserts its long ovipositor between bud scales and is therefore an "ovipositor prober". *Aprostocetus* n. sp. near *miridivorus* is both an "ovipositor prober" and an "ovipositor driller", as it probably inserts its terebra either inside the host oviposition wound or through the soft wooden substrate. In contrast, both *Telenomus* species are "metasomal probers". In fact, their metasoma is adapted to reach the host eggs by inserting at least part of it into the host oviposition sites, specifically between bud scales in the case of *Telenomus* sp. *laricis* group, or in the host oviposition incision in the case of *T. lopicida*.

We have shown that *Chaetostricha walkeri* is an egg parasitoid of *Calocoris quad-*

ripunctatus. This is a new host record and it suggests that previous ones were erroneous. In fact, *C. walkeri* has been reported from eggs of *Tortrix viridana* (Kolubajiv 1959 according to Du Merle 1983, Martinek 1963), from the coccid *Leucaspis pini* Htg. (Nikol'skaya 1952), or from unknown hosts, supposedly xylophagous larvae (Silvestri 1917 citing Föster) or Heteroptera eggs embedded in wood (Silvestri 1917). The eggs of *C. quadripunctatus*, the true host, were evidently overlooked because they were not visible externally.

Many of the available host records for other *Telenomus* species in the *laricis* group are similarly questionable, and a careful reassessment is needed before supposed host associations can be accepted as reliable.

ACKNOWLEDGMENTS

We are grateful, for insect identifications, to Paride Dioli (*Calocoris quadripunctatus*), John LaSalle (*Aprostocetus* n. sp. near *miridivorus*) and Gennaro Viggiani (*Chaetostricha walkeri*). We also thank the reviewers for their useful comments on the manuscript, Sebastiano Barbagallo and Santi Longo for collaboration and hospitality in Sicily, Beyene Ayano Ejigu for helping with data collection on *C. trivialis* in the laboratory, Mario Michelassi and Aldo Mommi for photographs and technical assistance, and Fabrizio Pennacchio for parasitoid measurements using the visual image analysis program. This research was financially supported by MURST 40%, MURST 60% and MiPA Research Project "Biological and integrated pest control in agricultural and forest plants", research group "Forest plants".

LITERATURE CITED

- Alexandri, M. P. and J. A. Tsitsipis. 1990. Influence of the egg parasitoid *Platytenomus busseolae* (Hym.: Scelionidae) on the population of *Sesamia nonagrioides* (Lep.: Noctuidae) in central Greece. *Entomophaga* 35(1): 61-70.
- Alomar, O. and R. N. Wiedenmann (eds.). 1996. *Zoophytophagous Heteroptera: Implications for life history and integrated pest management*. The Entomological Society of America, Thomas Say Publications in Entomology, Lanham, Maryland, 202 pp.
- Austin, A. D. 1983. Morphology and mechanics of the ovipositor system of *Ceratobaeus* Ashmead (Hymenoptera: Scelionidae) and related genera. *In-*

- ternational Journal of Insect Morphology and Embryology* 12(2/3): 139–155.
- Barbagallo, S. 1969. Appunti morfo-biologici su *Tetrastichus miridivorus* Domenichini (Hymenoptera: Eulophidae) parassita oofago di Eterotteri Miridi. *Bollettino di Zoologia Agraria e di Baccicoltura (Ser. II)* 9: 115–122.
- Barbagallo, S. 1970. Contributo alla conoscenza del *Calocoris (Closterotomus) trivialis* (Costa) (Rynchota-Heteroptera, Miridae). Morfologia dell'adulto e biologia. *Entomologica* 6: 1–104.
- Bogenschütz, H. 1978. Tortricinae. Pp. 55–89 In: W. Schwenke (ed.), *Die Forstschädlinge Europas*. 3 Band. Paul Parey, Hamburg, Berlin.
- Cobben, R. H. 1968. *Evolutionary trends in Heteroptera. Part I. Eggs, architecture of the shell, gross embryology and eclosion*. Centre for Agricultural Publishing and Documentation, Wageningen, 475 pp.
- Conti, E., S. Colazza and F. Bin. 1991. Imenotteri parassitoidi di uova endofitiche di Eterotteri: alcune associazioni nei Miridi e nei Nabidi. *Atti XVI Congresso Nazionale Italiano di Entomologia, Bari—Martina Franca*, 23–28 Sept. 1991: 929–931.
- Conti, E., P.F. Roversi and F. Bin. 1997. Egg parasitoids associated with arboreal mirids Hym.: Parasitica; Het.: Miridae). Proceedings from the 6th European Workshop on Insect Parasitoids, Valencia, 1–4 March 1997. *Boletín de la Asociación Española de Entomología, Suplemento al Volumen 21*: 94–95.
- Du Merle, P. 1983. Les facteurs de mortalité des oeufs de *Tortrix viridana* (L.) (Lep., Tortricidae). *Agronomie* 3(5): 429–434.
- Gauld, I. D. and P. E. Hanson. 1995. The structure of Hymenoptera. Pp. 102–137 In: P. E. Hanson and I. D. Gauld (eds.) *The Hymenoptera of Costa Rica*. Oxford University Press, Oxford, 893 pp.
- Graham, M. W. R. de V. 1987. A reclassification of the European Tetrastichinae (Hymenoptera: Eulophidae), with a revision of certain genera. *Bulletin of the British Museum (Natural History). Entomology series* 55(1): 116–117.
- Hinton, H. E. 1981. *Biology of insect eggs. Vol. I-III*. Pergamon Press, Oxford, 1125 pp.
- Huggert, L. 1983. On *Telenomus*, mainly European; redescriptions, new taxa, synonymies and combinations (Hymenoptera, Proctotrupoidea: Scelionidae). *Entomologica Scandinavica* 14: 145–167.
- Johnson, N. F. 1984. Systematics of Nearctic *Telenomus*: classification and revisions of the *podisi* and *phymatae* species groups (Hymenoptera: Scelionidae). *Bulletin of the Ohio Biological Survey* 6(3): 1–113.
- Kolubajiv, S. 1959. Orientacni pokusy s umelým chovem drobenky rodu *Trichogramma* z hmyzich lesnich skudcu. *Sborn ČSAZV-Lesnictvi*, 32(12): 1057–1070.
- Kullenberg, B. 1946. Studien über die biologie der Capsiden. *Zoologische Bidrag* 23: 1–522.
- Martinek, V. 1963. Nekteri vajecni cizopasnici lesnich skudcu a možnosti jejich pestovani. *Práce Výzkumných Ústavu Lesnických ČSSR* 26: 5–48.
- Mineo, G. and A. Sinacori. 1978. Studi morfo-biologici comparativi sugli stadi preimmaginali degli Scelionidi (Hym. Proctotrupoidea). IV. Nota su *Telenomus lopicida* Silv. *Bollettino dell'Istituto di Entomologia Agraria e dell'Osservatorio di Fitopatologia di Palermo* 10: 105–112.
- Nikol'skaya M. N. 1952. The Chalcid Fauna of the U.S.S.R. (Chalcidoidea). *Keys to the fauna of the U.S.S.R. No. 44*. Zoological Institute of the Academy of Sciences of the U.S.S.R., Moscow, Leningrad (Translated from Russian. Israel Program for Scientific Translations, Jerusalem 1963).
- Quicke, D. L. J. 1997. *Parasitic wasps*. Chapman & Hall, London, 470 pp.
- Roversi, P. F., E. Conti and F. Bin. 1998. Ooparasitoidi di Miridi arboricoli di ambienti forestali e agrari. *Atti XVIII Congresso Nazionale Italiano di Entomologia, Maratea*, 21–26 giugno 1998: 225.
- Silvestri, F. 1917. Contribuzione alla conoscenza del Genere *Centrobia* Förster (Hymenoptera, Chalcididae). *Bollettino di Zoologia Generale e Agraria della R. Scuola Superiore d'Agricoltura in Portici* 12: 245–251.
- Silvestri, F. 1932. Contribuzione alla conoscenza del *Lopus lineolatus* (Brullé) e di un suo parassita. *Société Entomologique de France, Livre du Centenaire*, pp. 561–565.
- Silvestri, F. 1939. *Lopus lineolatus* Brullé. Pp. 262–269 In: F. Silvestri, *Compendio di Entomologia Applicata. Parte speciale Vol. I*. Tipografia Bellavista, Portici.
- Smith, J. W. Jr. and R. N. Wiedenmann. 1997. Foraging strategies of stemborer parasites and their application to biological control. *Insect Science and its Application* 17(1): 37–49.
- Smith, J. W. Jr., R. N. Wiedenmann and W. A. Overholt. 1993. *Parasites of lepidopteran stemborers of tropical gramineous plants*. ICIPE Science Press, Nairobi, 89 pp.
- Southwood, T. R. E. 1956. The structure of the eggs of the terrestrial Heteroptera and its relationship to the classification of the group. *Transactions of the Royal Entomological Society of London* 108: 163–221.
- Vu, Quang Con and Van San Nguyen. 1987. Effectiveness of egg parasites (Hymenoptera) depending on the parasite abdomen structure and on the type of egg-batches in lepidopteran rice pests. *Zoologicheskij Zhurnal* 66(1): 60–65. [In Russian].
- Wagner, E. and H. H. Weber. 1964. *Faune de France. Vol. 67. Hétéroptères Miridae*. Fédération Française des Sociétés de Sciences Naturelles, Paris, 591 pp.